EEU45C09 / EEP55C09
Self Organising Technological Networks

Module Preliminaries

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Self Organising Technological Networks

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CONNECT
Networks of the Future

Some Videos to Warm Up...

https://www.youtube.com/watch?v=e8Prw9AZ9jw

https://www.youtube.com/watch?v=16W7c0mb-rE

Ack: Thanks to Prof Georgios Iosifidis (TU Delft)
for finding the second video ☺

Module Units

1. **Complex systems**
   - What is a complex system?
   - Local behaviour – global properties paradigm
   - Implicit system coordination
   - Self-synchronisation
   - Adaptivity to changes
   - Reductionism vs. emergence

2. **Information**
   - Physics vs. Communication Engineering
   - Entropy and complexity
   - 1D and higher dimensional lattices
   - Cellular automata
   - Example applications: Cellular networks, Internet of Things

Module Units

3. **Agent-based modelling**
   - ➢ Lab-based unit [**Harun**]

4. **Networks**
   - ➢ What is a network?
   - ➢ Graph theory vs. network science
   - ➢ Networks for all tastes: random, regular, small world, scale free
   - ➢ Centrality, clusters of nodes
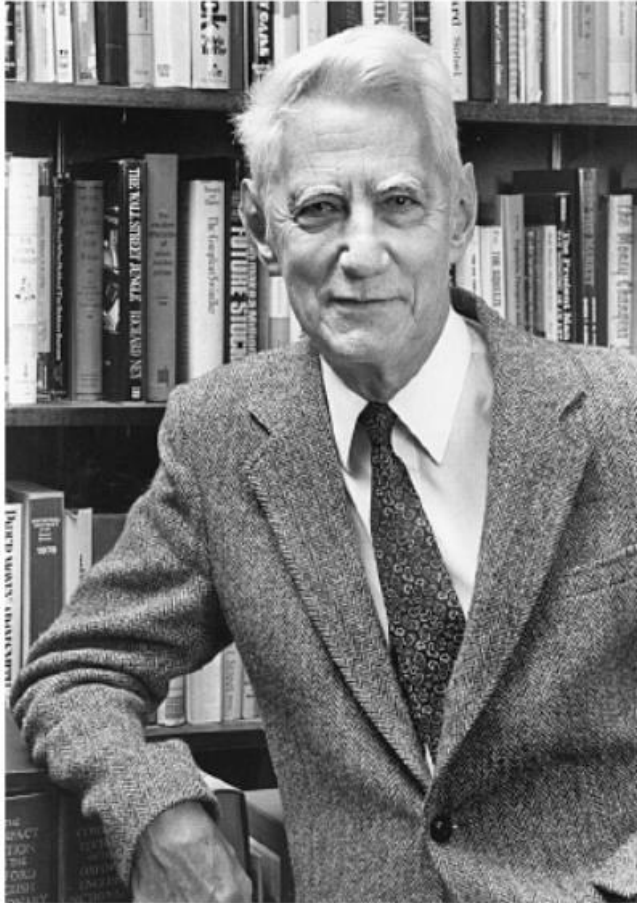   - ➢ Example application: Social networks

Module Units

5. Dynamics

- ➢ Nonlinear dynamics, chaos, the butterfly effect
- ➢ Determinism vs. randomness
- ➢ Fractal geometry: self-similarity, fractal dimension
- ➢ Example application: telecom traffic modelling
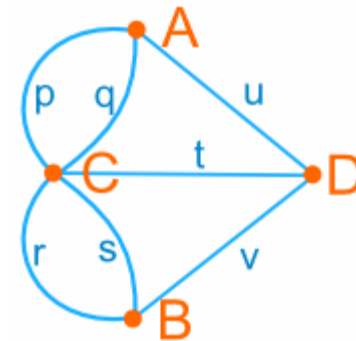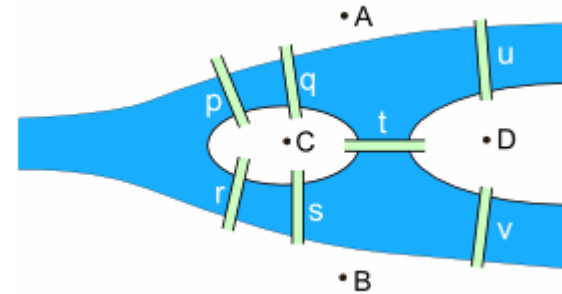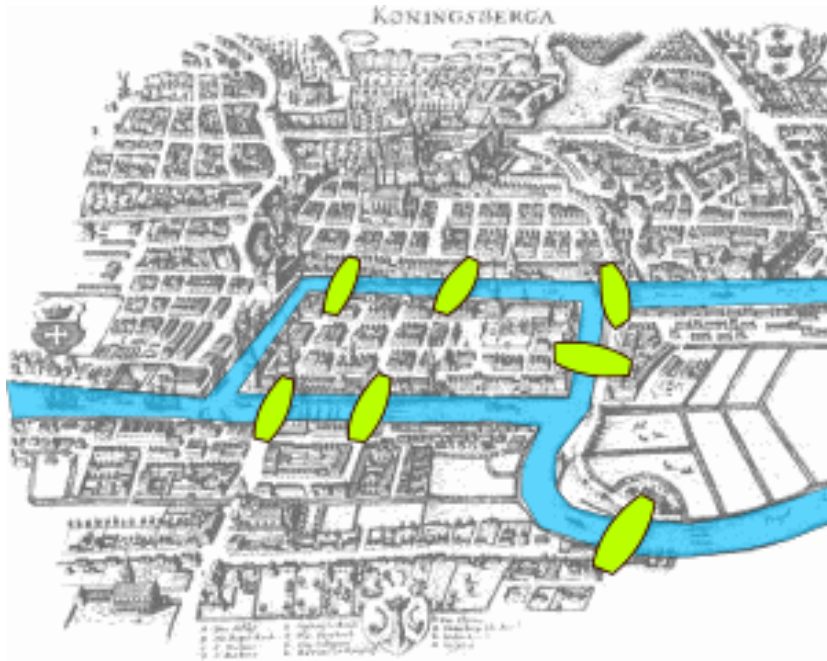
Unit 2 – sneak peek

Shannon worked at Bell Labs (part of AT&T)

Major question for telephone communication: How to transmit signals most efficiently and effectively across telephone wires?

Shannon adapted Boltzmann's statistical mechanics ideas to the field of communication.

Claude Shannon, 1916-2001

https://www.imdb.com/title/tt5015534/?ref_=vp_back

Unit 4 – sneak peek

Can you draw each line p, q, r, s, t, u and v **only once**, without removing your pencil from the paper (you may start at any point) ?

https://en.wikipedia.org/wiki/Seven_Bridges_of_K%C3%B6nigsberg
https://www.mathsisfun.com/activity/seven-bridges-konigsberg.html

Unit 5 – sneak peek

Benoit Mandelbrot, 1924–2010

Many mathematicians have studied the notions of self-similarity, and of "fractional dimension" and what an object with a fractional dimension would look like.

The term *fractal*, to describe such objects, was coined by the mathematician Benoit Mandelbrot, from the Latin root for "fractured".

Mandelbrot's goal was to develop a mathematical "theory of roughness" to better describe the natural world.

He brought together the work of different mathematicians in different fields to create the field of *Fractal Geometry*.

Timetable

Mon, 15:00	AAP 2.04
Tue, 15:00	Lloyd 1.20
Wed, 15:00	Arts 3071
Thu, 16:00	AAP 0.26
Fri, 10:00	AAP 2.15

CA-Exam Split

Lab + group project	50% (10% + 40%)
In-class quizzes (2)	40% (20% each)
Flipped Classroom Activity	10%

The Lecturers

Prof Nicola Marchetti	• Lectures	**nicola.marchetti@tcd.ie**
Prof Harun Siljak	• Labs, Project, Critical Systems	**harun.siljak@tcd.ie**

Flipped classroom activity

❑ **Preparation piece for a class discussion**
❑ **Participation in class discussion**
❑ **Feedback on class discussion**

Project (1)

❑ **3 individual labs** as prep for **group project + 6 videos on NetLogo coding**

❑ Max 3 students per project group

❑ Participation in labs marked

❑ **Graphical presentation and group report** on the project at the end of the term

Project (2)

❑ Lab schedule

- *Lab 1,* **Fri 09 Feb**

- *Lab 2,* **Fri 22 Mar**

- *Lab 3,* **Fri 05 Apr**

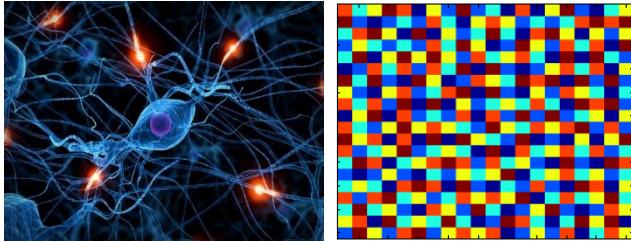*** Fri 15 Mar, lecture in lab slot to replace Thu 14 Mar (Happy Pi Day & Happy Birthday, Einstein)**

Quizzes

❑ Closed book

❑ Dates

- Quiz #1: **Fri 01 Mar, 10:00-10:50**

- Quiz #2: **Fri 12 Apr, 10:00-10:50**

WhyCOM Research Programme
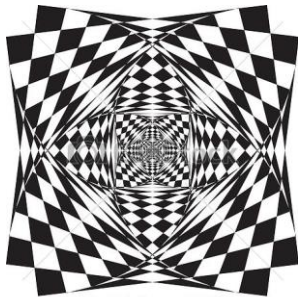
Complex Systems Science

signal processing

ALLOCATE

New PHY for
Better Resource Allocation

Smart Things

Simple Things

OUTCOME

FAST

ADAPT

SHARE

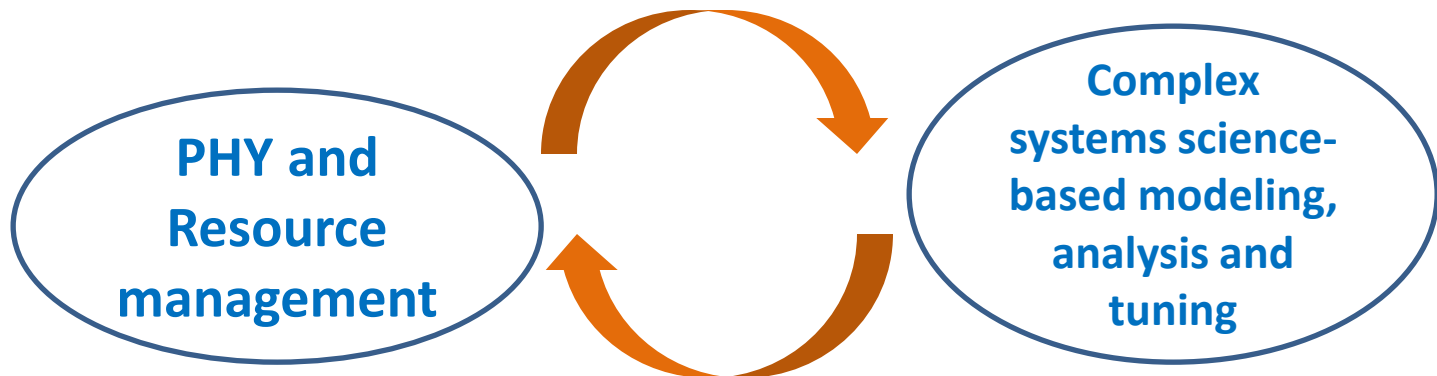https://nicolamarchetti.wordpress.com/
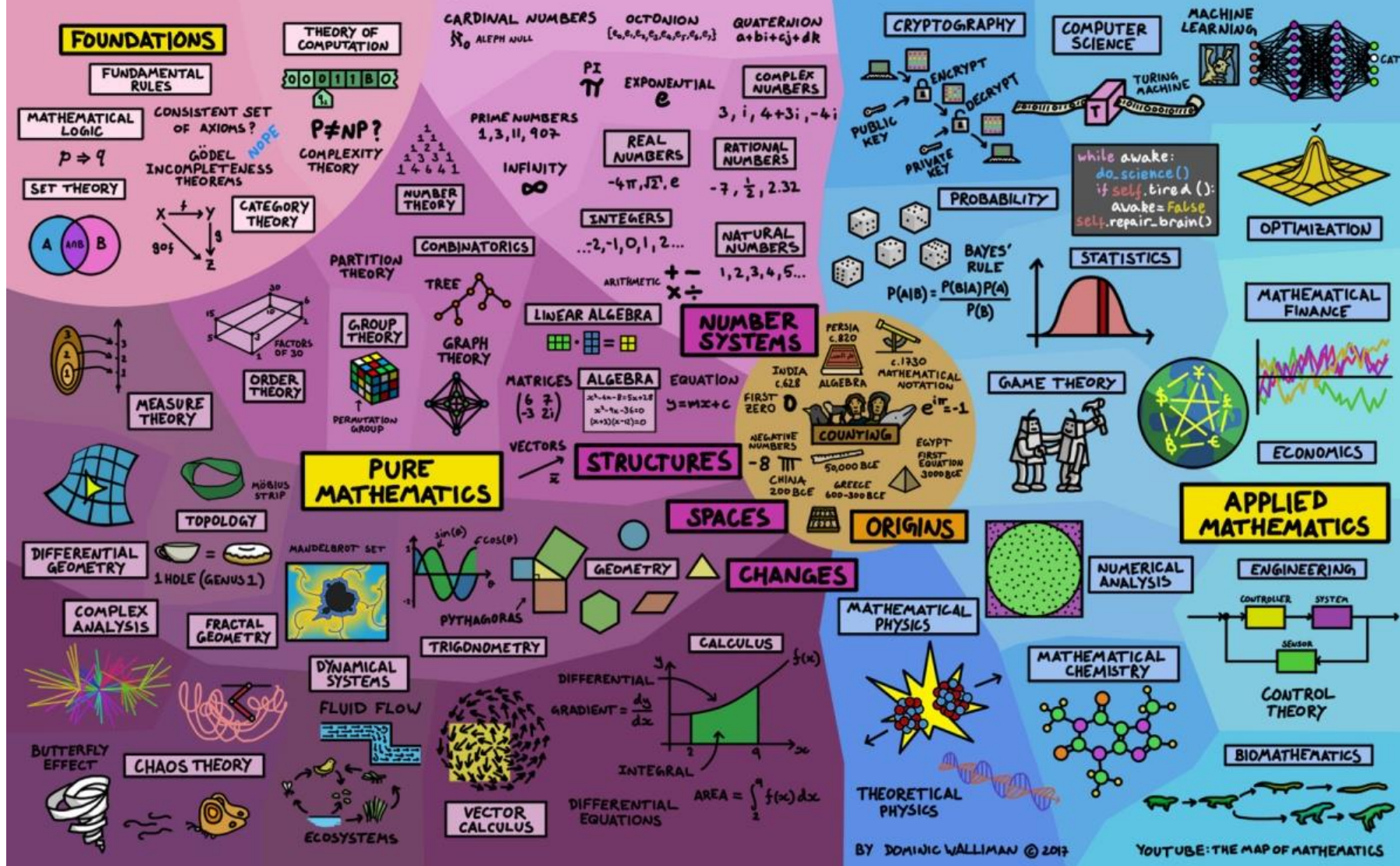
WhyCOM Research Programme

$$E_C = \sum_{M=1}^{\infty} (h(M) - h)$$

$$H(\sigma) = -J \sum_{\langle i,j \rangle} \delta_{\sigma_i, \sigma_j}$$

- Draw on concepts from **information theory, network science, biology**

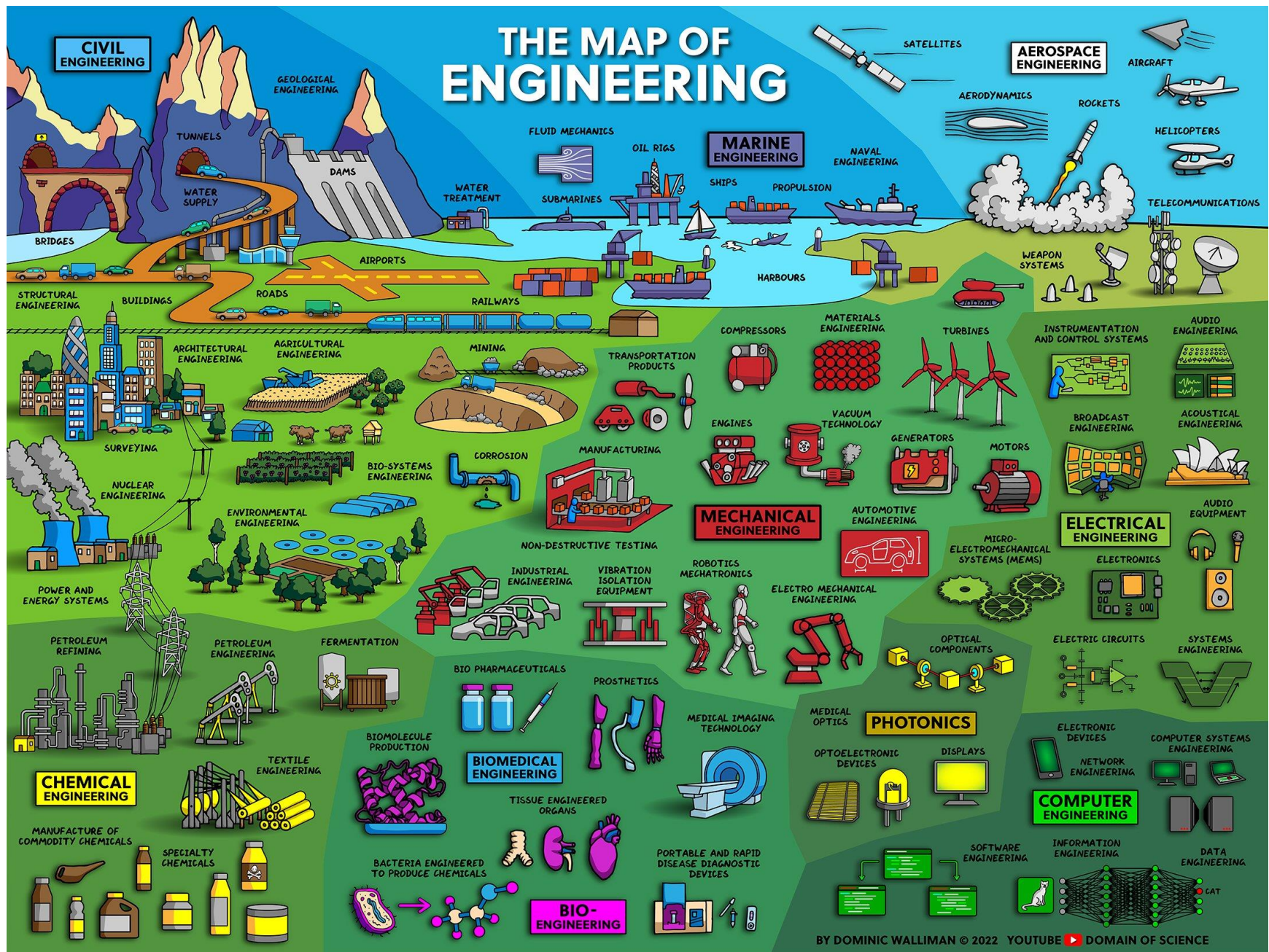- Find **new ways** to model, analyse and tune telecom networks

PHY and Resource management

Complex systems science-based modeling, analysis and tuning

https://nicolamarchetti.wordpress.com/

The Map of Mathematics

BY DOMINIC WALLIMAN © 2017

YOUTUBE: THE MAP OF MATHEMATICS

THE MAP OF ENGINEERING

By Dominic Walliman © 2022 YOUTUBE DOMAIN OF SCIENCE

https://www.youtube.com/watch?v=pQgxiQAMTTo

Resources

❑ Module material will be available through BlackBoard:

http://mymodule.tcd.ie/

❑ You can contact us by email whenever needed:

nicola.marchetti@tcd.ie

harun.siljak@tcd.ie